EXPLORATION OF SYNERGIES BETWEEN ACADEMIC RESEARCH AND ACTUAL PRACTICE FOR IMPROVED CONSTRUCTION WASTE MANAGEMENT

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With the increase in the construction waste generation rates in recent times, concerns related to the attainment of global sustainability triggered as well. Consequently, issues related to the effective management of construction waste have got the attention of waste management researchers more than ever before. Governments worldwide allocate massive funds into research and development (R&D) to make focused policies for protecting the environment and conserve their limited resources. Hong Kong, a special administrative region (HKSAR) of the Republic of China, like many other advanced regions in the world, also faces serious challenges to protect the environment and achieve sustainability. In order to arrive at sustainable solutions through the implementation of well-designed strategies, exploration of synergies between academic research and the actual practice has become more crucial now. To address this, the research method considers an exploratory approach to investigate the 1) academic research being conducted in the area of construction waste management; 2) actual practice by exploring the waste management infrastructure support system, construction waste generation, reuse and disposal trends, and the implemented policies; and 3) exploration of synergies between the actual and academic practices for improved construction waste management in Hong Kong. For scope purposes, this study considers 20 years period, i.e., 2001-2020. Recommendations highlighting the need for bridging the gap between academic research and actual practice are also delineated for future researchers.

Keywords: Construction waste, Exploratory research, Research trends, Waste infrastructure facilities, Sustainability, Policies.

1 INTRODUCTION

Like many other industries, the construction industry contributes significantly to the improved economic situation of a country. In contrast to this, it has a daunting impact on the environmental situation due to massive waste generation resulting from the construction activities and disposal of the generated waste at landfills (Oyedele et al. 2013). Based on the severity of the problem, governments and researchers worldwide have taken this issue on a priority basis. Consequently, many focused policies and innovatively engineered solutions have been proposed to date to protect ecological well-being by reducing the adverse effects of waste and finding the beneficial reuses of it (Melosi 2000). These measures were primarily developed around a well-established 3R principle for effective waste management, i.e., reduce, reuse, recycle.
Despite these focused efforts from academicians and practitioners, inter-harmony between academic research and actual practice is crucial to ensure continuous sustainable developments in construction waste management. Keeping this in mind, this study aims to explore the synergies between academic research and actual practice and provides a way forward for bridging the gaps to elevate the construction waste management situation in Hong Kong.

The remainder of the paper is logically structured as follows. Section 2 briefly explains the research method considered for this study. Section 3 presents an overview of academic research. Section 4 discusses the actual practice from a multitude of aspects. Section 5 sheds light on the exploration of synergies before concluding the study.

2 RESEARCH METHOD

Figure 1 presents the overall research method considered in this exploratory research study and is logically partitioned into the following three phases. Firstly, the academic research on construction waste management was investigated from different aspects and analyzed to mark the researchers' interest areas in Hong Kong. Secondly, the actual industry practice is explored by emphasizing the following two aspects, i.e., the exploration of the waste infrastructure support system in Hong Kong and the trend analysis for the construction waste management scenario by considering the waste statistical data retrieved from the environmental protection department, Hong Kong (EPDHK). In the third phase, with the help of the findings from the succeeding two phases, synergies were explored, and a way forward is provided for bridging the gap between academic research and actual practice. In the end, study conclusions were provided.

3 PHASE 1: ACADEMIC RESEARCH

This section provides the overall scenario of the academic research conducted on construction waste management in Hong Kong during the last two decades, i.e., 2000 onwards. For literature collection, journal articles published in the renowned Web of Science (WOS) and Scopus databases were considered here, using the keywords 'construction waste management' and 'Hong Kong'. In total, 70 journal articles were shortlisted after deleting the redundant articles from the two databases, which matched the study scope. Figure 2 presents the growing publication trend in the last two decades.
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For brevity, only the keywords analysis of the shortlisted literature spanning over the three time periods were considered here. 1st period contains 18 papers, 2nd period contains 10 papers, and 3rd period contains 42 papers respectively. Moreover, to view the actual sense of keywords distributions, the basic keywords searched initially were intentionally omitted.

Figure 3 represents the distribution of the keywords for the considered three periods using the software ‘Wordle’. In the 1st period, the researcher's top 5 keywords are 'concrete,' 'aggregate,' 'recycled,' 'CDW,' and 'environment'. The researchers' top 5 keywords during the 2nd period are 'building,' 'CDW,' 'modeling,' 'sorting,' and 'scheme'. For the 3rd period, the top 5 keywords used are 'building,' 'life-cycle,' 'assessment,' 'big data,' and 'green'. From the viewpoint of research quality, most of the published papers, i.e., around 70% of the articles were published in top-quality academic journals including, Waste Management, Resources Conservation, and Recycling, Journal of Cleaner Production, Automation in Construction, etc.

4 PHASE 2: ACTUAL PRACTICE

4.1 Waste Infrastructure Support System

Effective management of waste material requires a series of interconnected complex processes related to collecting, transportation, and processing of waste material (Das and Bhattacharyya 2015). Physical facilities concerning these processes usually lead to the description of a country's waste management infrastructure. Like many other developed
regions of the world, Hong Kong has good infrastructure support for managing construction waste. Nevertheless, it is generally constrained by the limited capacities of facilities. Therefore, continuous efforts are always needed to maximize the utility of the supporting systems.

In Hong Kong, construction waste is divided into two basic categories, i.e., inert waste and non-inert waste, in alignment with the categorization by Hossain et al. (2017). Inert waste (public fill) includes debris, rubble, earth, and concrete, appropriate for land reclamation and site formation, and stored at public fill facilities for later reuse. Once the inert waste is sorted, materials like concrete and asphalt can be recycled at a recycling facility to form recycled aggregates for construction activities. Whereas the left-over concrete waste arises from the aggregate production process sends to the landfill for final disposal. The residual non-inert type includes bamboo, timber, vegetation, packaging waste, and other organic materials. In contrast to public fill, non-inert waste is not suitable for land reclamation and subject to recovery of reusable or recyclable items at recycling facilities. Thus, the left-over is disposed of at landfills. Independent of the waste type, construction waste all together pose a severe threat to the environmental well-being of Hong Kong.

4.2 Construction Waste Management Scenario

Hong Kong is considered one of the most densely populated places in the world, with over 7.5 million people in a 1,107-square-kilometre territory (Census and Statistics Department 2019). With the recent growth in the construction sector, construction activities’ value witnesses an increase of approximately HK$150 billion from 2008 to 2017 (Legislative Council 2017). Consequently, Hong Kong, like many other regions of the world, is producing a large amount of construction waste. In 2018, 4081 tonnes per day of construction waste was disposed of in the landfills (EPDHK 1997).

![Figure 4](https://via.placeholder.com/150)

**Figure 4.** Construction waste trends, (a) generation, reuse, and disposal, (b) disposal at three landfills.

The construction waste management scenario for the considered 20 years in terms of waste generation, reuse, and disposal is presented in Figure 4(a). Based on the uneven trend lines, it is evident that the waste generation and reuse patterns cannot be generalized over a certain period. Apart from the volume of construction activities in a particular year, these trends are mostly under the influence of implemented policies, indicating low social
awareness and commitment issues. However, the trend is typically consistent over a fixed period for the waste disposed at landfills. Figure 4(b) represents the construction waste disposal pattern at the three strategic landfills in Hong Kong, i.e., West New Territories (WENT), South East New Territories (SENT), and North East New Territories (NENT). The increased amount of construction waste is being disposed of at these landfills, threatening the overall environmental situation by adding more pressure on these nearly saturated fixed capacity landfills (Lou and Fabian 2019). Consequently, disposal at these landfills may no longer be feasible as the main alternative for waste management. Therefore, efforts are needed and justified to incorporate reverse logistics principles into actual practice by promoting the concepts like material recovery, circular economy, resource conservation, essential for the sustainable development of Hong Kong (Ahmed and Zhang 2021).

In addition to these statistics, and due to the criticality of the construction waste management situation in Hong Kong, the government has put much effort into dealing with the waste management issues and has devised several policies. Lu and Tam (2013) provided a comprehensive review of construction waste management policies in Hong Kong for about three decades, i.e., 1980-2012. These include waste disposal ordinance (1980); a 10-year comprehensive framework to reduce construction waste (1989); green manager scheme (1994); waste reduction framework plan (1998); landfill charging scheme (1999) based on the polluter pays principle and user-pays principle; guidelines for promoting the use of recycled aggregates in concrete production (2003); government notification for implementing on-site waste management and paying for safety schemes (2003); pilot recycling plant (2004) commissioned by CEDD for enhancing recycled aggregate production; trip ticket system (2004), which is the enhanced form of landfill charging scheme introduced in 1999; construction waste disposal charging scheme (2005); best practice guide for environmental protection on construction sites (2009), and a 10-year blueprint for sustainable use of resources with the theme of "use less, waste less" (2013). All these efforts indicate a firm intention to improve the waste management scenario of Hong Kong, but improvement is a continuous process. To make it sustainable academic research and actual practice need to have synergy among them.

5 PHASE 3: EXPLORING SYNERGIES

This study provides an exploratory analysis of the construction waste management situation in Hong Kong from academic research and actual practice aspects. After exploring these two aspects for 20 years, i.e., 1998-2018, synergies were identified. A way forward is recommended for bridging the gap between academic research and actual practice for effective construction waste management in Hong Kong.

From Figure 3, it is observed that the focus of the 1st period is on the recycled aggregate production to protect the environment. For the 2nd period, the focus is on waste sorting and estimation modeling to avoid the charging scheme's disposal charges. For the 3rd period, the focus is on the life cycle assessment for a greener environment.

The identified policies (section 4.2) correlate with both the keywords distribution and the waste generation, reuse, and disposal trends from the actual practice standpoint. For example, the policies recommended before 2000 such as, 1998's waste reduction framework plan and 1999's landfill charging scheme, validate the keywords used for the 1st period and the waste trends that get better by the end of the 1st period (2010). Similarly, the policies suggested between 2000-10 impact the keywords distribution for the 2nd period and the waste generation, reuse, and disposal trends. A 10-year policy document for sustainable use of resources devised in 2013 reflects the association on the 3rd period keywords and improved waste reuse and disposal trends.

An overall synergic pattern between academic research and actual practice is unearthed through these explorations. It includes designing the focused policies to solve a problem and then, later, conducting the academic research for evaluating the effectiveness of the
recommended implemented policies. However, by looking at the timelines, a visible lag in synergies between academic research and actual practice has been found, which needs to be minimized by providing more integrative research opportunities among the sectors, i.e., academia and industry. Based on the previous academic-industry synergistic pattern, research on sustainable development and environmental conservation is expected concerning construction waste management issues in Hong Kong.

6 CONCLUSIONS

Construction waste shares a significant proportion of overall municipal solid waste. Inert and non-inert classification of construction waste has substantially streamlined the management processes. However, the mounting challenges continually require committed measures from all the concerned stakeholders. Keeping this in mind, this study explores the synergies between academic research and actual practice and aims to narrow down the gap between them. Key conclusions of this study are (1) application of innovative and advanced technological concepts is a recent and encouraging trend observed in recent times, i.e., 2016-2020; (2) uneven waste generation and reuse patterns over the last two decades were strongly influenced by the implemented policies; (3) continuously higher waste volumes being sent to the landfills in particular SENT landfill, which leads to understandable capacity issues of the already saturated landfills; (4) strong need for the academic-industry collaborative linkages and promotion of concepts like life-cycle assessment, reverse logistics, green environment and alike for sustainable construction waste management in Hong Kong.

References


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